REVIEW PROBLEMS WILL NOT BE COLLECTED or GRADED (all DO-IT-YOURSELF)

**DO-IT-YOURSELF** Review Problem 4-1 (Unit B-3)

Answer the followings (explain in your own words).
(a) What is the difference between ideal and real flow of flow around a circular cylinder?
(b) What is “Stokes flow”?
(c) What are “separation bubbles”?
(d) What is “von Karman vortex street”?
(e) What is the difference between “subcritical” and “supercritical” flows?

**DO-IT-YOURSELF** Review Problem 4-2 (Unit B-3)

Consider a superposition of uniform flow (from left to right): \( \psi = V_x y \) and a source: \( \psi = \frac{\Lambda}{2\pi} \theta \)

(a) Calculate the location(s) of stagnation point(s): \((r, \theta) = (?, ?)\)
(b) Determine the equation of stagnation streamline: \( \psi = ? \)
(c) Let \( R = \Lambda/2\pi V_x \), and determine the equation of solid surface: \( r/R = ? \)

**DO-IT-YOURSELF** Review Problem 4-3 (Unit B-3)

Consider a superposition of uniform flow (from left to right): \( \psi = V_x y \) and a doublet: \( \psi = -\frac{\kappa \sin \theta}{2\pi} \frac{1}{r} \)

(a) Let \( R = \sqrt{\frac{\kappa}{2\pi V_x}} \), and determine the location(s) of stagnation point(s): \((r, \theta) = (?, ?)\)
(b) Determine the equation of stagnation streamline: \( \psi = ? \)
(c) Let \( r = R \) and determine the velocity distribution: \( V_r = ? / V_\theta = ? \)
(d) Let \( r = R \) and determine the pressure coefficient: \( C_p = ? \)

**DO-IT-YOURSELF** Review Problem 4-4 (Unit B-4)

Answer the followings (explain in your own words).
(a) Explain three patterns of stagnation point(s) in lifting flow over a cylinder (potential flow analysis).
(b) What is “circulation”?
(c) What is “Kutta-Joukowski theorem” applied for a spinning circular cylinder?
(d) What is “starting vortex”?
(e) What is the “Kutta condition”?

**DO-IT-YOURSELF** Review Problem 4-5 (Unit B-4)

Consider a superposition of nonlifting flow over a cylinder and a vortex located at the center of the cylinder:

\[
\psi = (V_x r \sin \theta) \left( 1 - \frac{R^2}{r^2} \right) + \frac{\Gamma}{2\pi} \ln \frac{r}{R} \quad \text{(Note: } R \text{ is the radius of the cylinder)}
\]

(a) For the case of \( r = R \) (surface of the cylinder), determine the stagnation point(s) \( \theta = ? \). Let \( \Gamma = 3\pi V_x R \) \((\Gamma < 4\pi V_x R)\).
(b) For the case of \( r = R \) (surface of the cylinder), determine the stagnation point(s) \( \theta = ? \). Let \( \Gamma = 4\pi V_x R \).

**Answer Keys** (No guarantee for 100% accuracy. For your “self-checking” purposes only. Do not “start” from answer keys!)
(a) \(-48.6 \text{ deg} \) \(228.6 \text{ deg}\) (b) \(-90 \text{ deg} \) \(270 \text{ deg}\)
(DO-IT-YOURSELF) Review Problem 4-6 (Unit B-4)

Consider, once again, a superposition of nonlifting flow over a cylinder and a vortex located at the center of the cylinder:

$$\psi = (V_\theta r \sin \theta) \left(1 - \frac{R^3}{r^3}\right) + \frac{\Gamma}{2\pi} \ln \frac{r}{R} \quad \text{(Note: } R \text{ is the radius of the cylinder)}$$

For the case of \( \theta = -\frac{\pi}{2} \) but \( r \neq R \), determine the stagnation point(s) \( (r = ?) \) in terms of \( R \). Let \( \Gamma = 5\pi V_\theta R \) \( (\Gamma > 4\pi V_\theta R) \).

Answer Keys (No guarantee for 100% accuracy. For your “self-checking” purposes only. Do not “start” from answer keys!)

\( r = 0.5R \) and \( 2R \)